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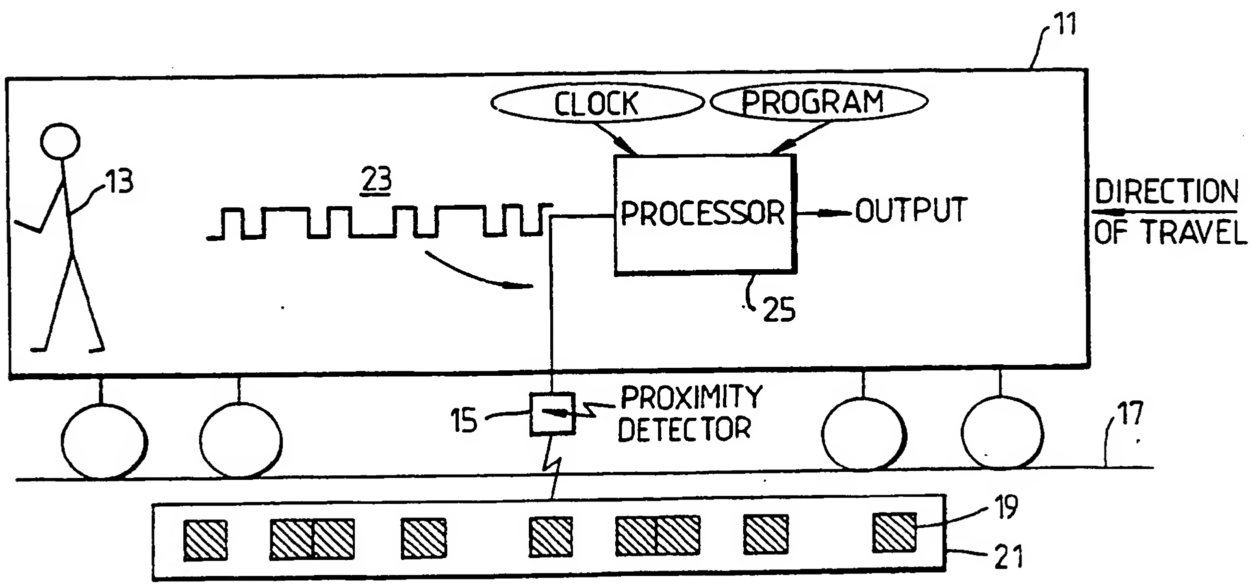
(58) Field of search
UK CL (Edition J) G4Q QBAC QBAE QBY
INT CL[4] B61L, G08G

(54) **Railway vehicle location system**

(57) The system comprises a passive coded device mounted beside the track at stations, junctions, etc. A reader on the train 11 scans the device and decodes a digital message giving the location. The device consists of a number of metal plates 19 fixed on a non-conductive base 21 extending along the track. An inductive proximity detector 15 carried by the train passes closely over the plates and produces a pulse for the duration of the proximity. The plates may be arranged in a Manchester 2 code and may alternatively be arranged across the track, with corresponding increase in the required number of detectors.

Fig. 2.



At least one drawing originally filed was informal and the print reproduced here is taken from a later filed formal copy.

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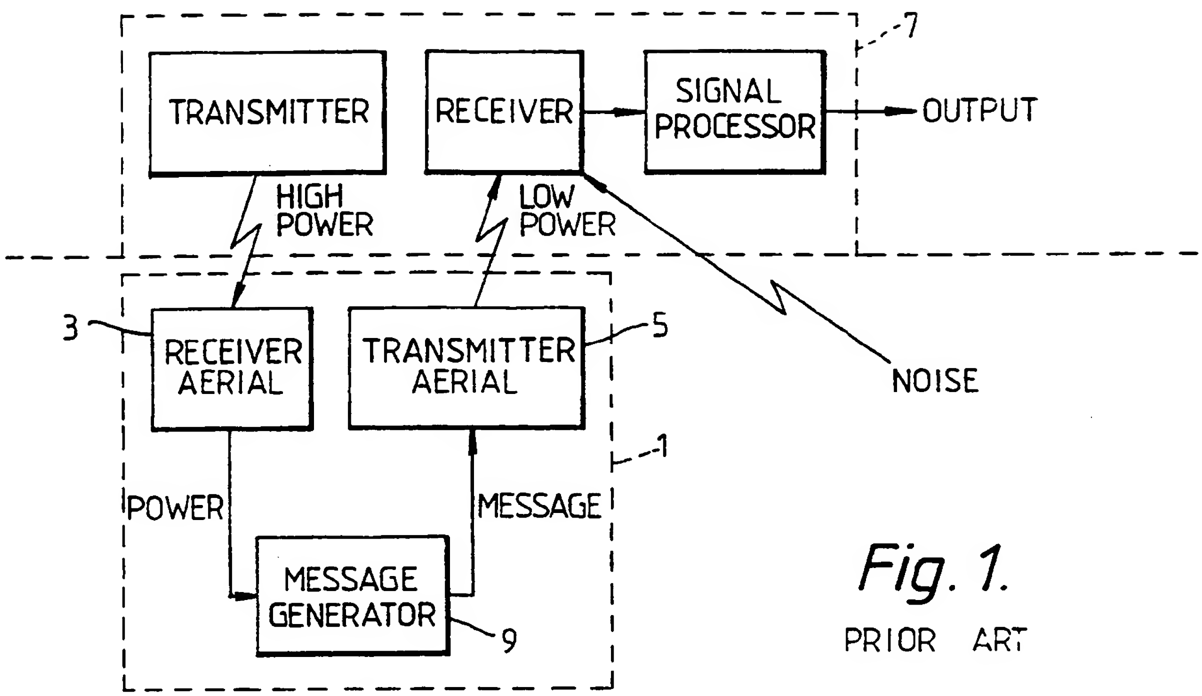
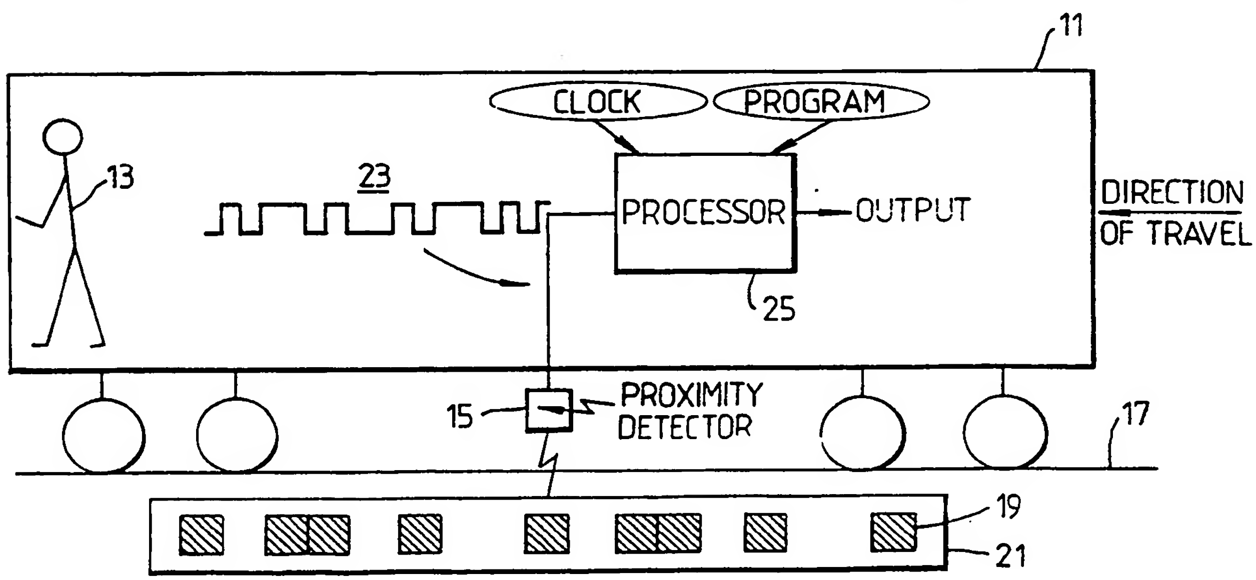


Fig. 1.
PRIOR ART

Fig. 2.



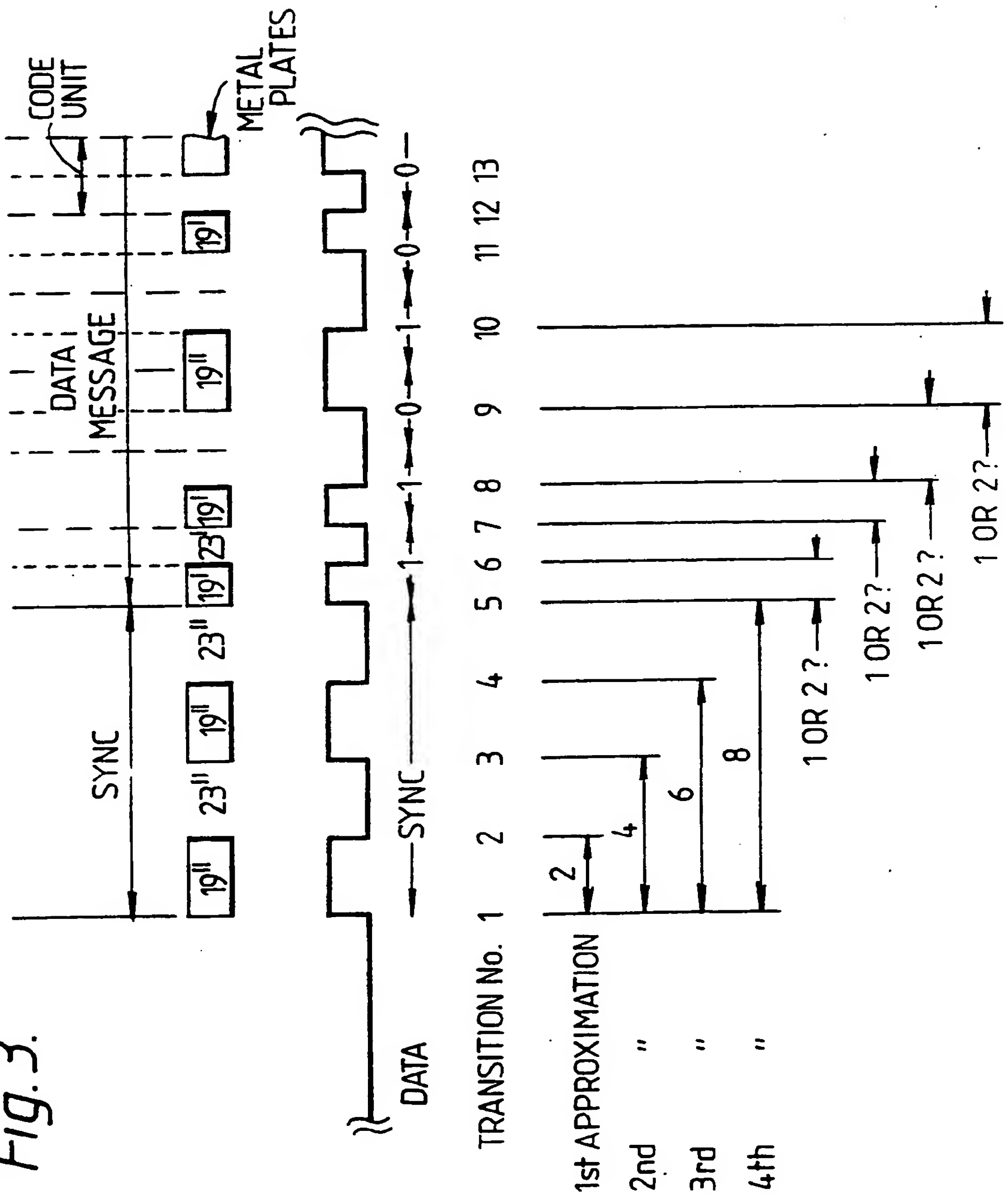
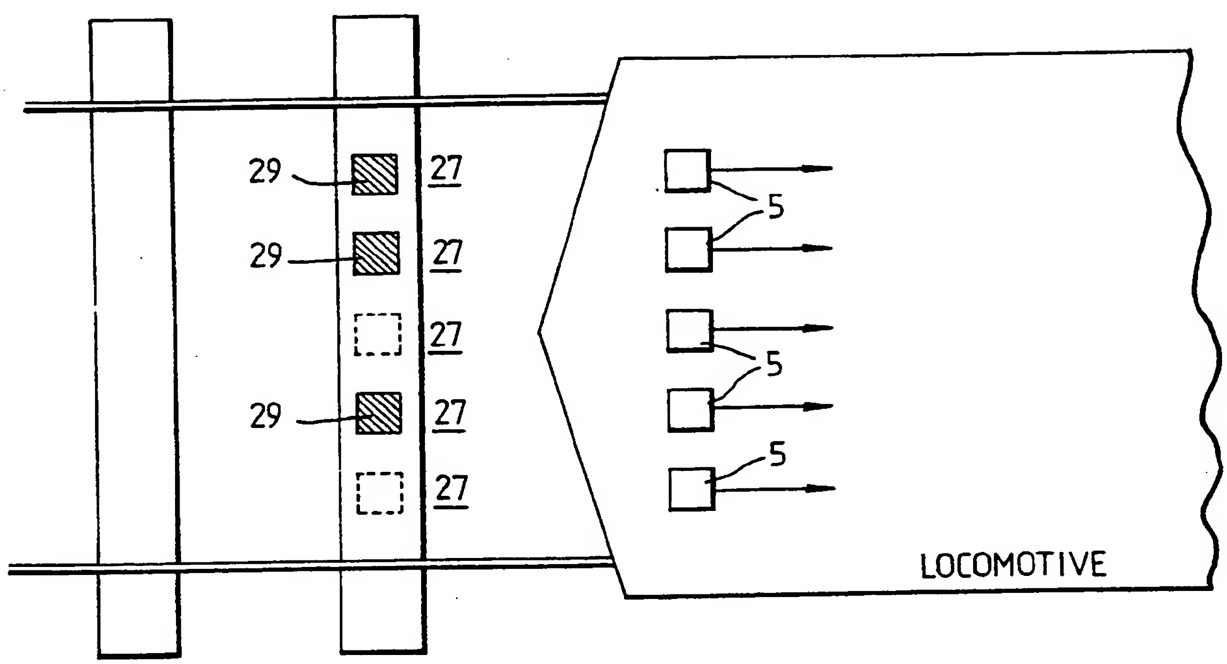

CODE UNIT
METAL PLATES
SYNC
DATA MESSAGE
19''
23''
19''
23''
19'
23'
19'
19''
19'
DATA
SYNC
1
1
0
1
0
0
TRANSITION No. 1 2 3 4 5 6 7 8 9 10 11 12 13
1st APPROXIMATION
2nd "
3rd "
4th "
2
4
6
8
1 OR 2 ?
1 OR 2 ?
1 OR 2 ?
1 OR 2 ?

Fig. 3.

Fig.4.



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Railway Vehicle Location System

This invention relates to a railway vehicle location system for use by a railway vehicle in determining its position along a track.

Transponders, and in particular passive transponders, have been used to identify objects, vehicles and locations in railway systems. In particular, on guided transport systems, transponders on vehicles may be used to identify the vehicles passing a reader on the track. Alternatively, transponders on the track may be used to identify particular locations to passing vehicles, by means of readers on-board the vehicles.

A typical passive transponder (which is usually intended to be as cheap as possible) is a sealed unit 1, as shown in Figure 1, containing electronic circuits, together with receiver and transmitter aerials 3 and 5. Power at a high frequency, from the reader 7, is used to energise the transponder circuits inductively via its receiver aerial 3, and this causes the transponder to transmit a stored message, operated by a message generator 9, to the reader, via the transmitter aerial 5. Some transponders may also be capable of transmitting different data messages, according to the state of controlling inputs (e.g. relay contacts).

Because of the poor efficiency of energy transfer between the reader and the transponder, the transponder message received by the reader often has a very low signal-to-noise ratio, making the reading circuits prone to interference (e.g. from electric traction systems), and also costly and complex. Moreover, since the transponder contains electronic circuits, which must be designed and packaged to be capable of surviving in harsh environments, it is often relatively costly in practice.

It is an object of the present invention to overcome at least some of these disadvantages of known transponder systems.

According to the present invention, a railway vehicle location system comprises a trackside transponder and a reader mounted on a railway vehicle, the transponder comprising a plurality of passive metal plates disposed adjacent the track in such relation to proximity detector means mounted on the vehicle that a signal pulse arises in the proximity detector means for the duration of proximity between the detector means and each metal plate as the vehicle passes the transponder, the plurality of plates thereby producing a signal code identifying to the vehicle the location of the transponder. The proximity detector means may operate by magnetic induction.

The signal code may be constituted by the length and relative position of the metal plates in a series, and may comprise a series of code units, each code unit comprising a pair of opposite binary elements in an order determining the value of the code unit, one binary element being represented by a metal plate and the other binary element being represented by the absence of metal plate in a predetermined position.

The metal plates may be disposed in the direction of travel and be of one or two units length interspersed with spaces of one or two units length, according to the value of successive code units, equal or different.

Alternatively, the signal code may be constituted by the presence and absence of metal plates in a parallel array of similar

metal plates relative to the direction of vehicle travel, there being a respective proximity detector for each potential metal plate position.

Moreover, the signal code may be constituted by the presence and absence of metal plates in a series/parallel array of similar metal plates, there being a respective proximity detector for each row of the array, the rows lying in the direction of vehicle travel.

In the serial arrangement, transitions between the presence and absence of plates may be detected and the signal code determined from the time between successive transitions.

The series of metal plates may be preceded by a synchronisation pattern of metal plates indicating to the reader the timing of code units in the following series of metal plates. There may be such a synchronisation pattern at both ends to accommodate vehicle travel in both directions.

The series of metal plates may further include a signal code indicative of the direction of travel.

A railway vehicle location system will now be described, by way of example, with reference to the accompanying drawings, of which:

Figure 1 is a block diagram of a known radio transponder identification/location system;

Figure 2 is a diagram of a locomotive on a track carrying a serial pattern of transponder plates;

Figure 3 is a diagram of a serial pattern of transponder plates illustrating the derived transitions; and

Figure 4 is a diagram of a locomotive on a track carrying a parallel pattern of transponder plates.

Referring to the drawings, a known radio transponder system has already been described as illustrated in Figure 1.

Figure 2 shows a locomotive 11 with driver 13, the locomotive carrying an inductive proximity detector 15 of known form, which is mounted to run alongside the track, whether between or outside the rails 17. A pattern of conductive metal plates 19, made for example, of aluminium, is mounted on a non-conductive base 21, which is fixed

to the sleepers (not shown). Depending upon the length of the pattern, the base 21 may be in sections although the spacing of the sections must be controlled to conform to the basic pattern requirements, as will be explained with reference to Figure 3.

The proximity detector 15 produces a two level signal according to its position in proximity to a metal plate, i.e. over one, or not over one. The position of the plate pattern is such that the detector runs within about 100 millimetres of the surface. The pattern may of course be mounted on a vertical 'base' the detector then running alongside it.

Figure 2 shows a typical serial data pattern 23 as produced by the proximity detector, the detector providing this signal to a data processor 25 which incorporates a clock pulse generator and a program for the analysis of the signal. The output of the processor is the identity of the particular location, a station or intersection for example, which is displayed to the driver and perhaps also transmitted by radio to a control centre.

Referring now to Figure 3, this shows a series of plates 19 some (19') of one 'unit' length and some (19") of two units length. The spacings 23 between plates are similarly of one unit (23') or two units (23") length, in the direction of travel.

The particular signal code employed in this example is that known as the Manchester 2 code, according to which an individual code unit, logical '0' or logical '1' is represented by two binary elements in a particular order. Thus, logical '0' is represented by 01 and logical '1' by 10. In a series of code units therefore, e.g. logical '0', logical '1', logical 1, logical 0, there will be single 0's and 1's and pairs of 0's and 1's in sequence according to the value of successive code units. If a binary element of value '1' is represented by a unit length of metal plate and a binary element of value '0' by a unit length of space then a signal code in metal plates will be represented by plates of one and two units length interspersed by spaces of one and two units length as shown in Figures 2 and 3.

Decoding of such a pattern relies upon first detecting the transitions between spaces and plates and then determining the time between transitions. Since the time between transitions clearly depends upon the speed of the train, a reference time is provided by a sync pattern preceding the coded signal message as shown in Figure 3. In this case the sync pattern comprises a two-unit metal plate 19" followed by a two-unit space 23" and this cycle repeated once.

At each transition from a '0' to a '1', i.e. from space to plate, the processor sets a clock to time the duration of the '1'. Following the next 1/0 transition the processor times the duration of the '0' before the new 0/1 transition and if comparable (i.e. within a tolerance margin) averages the two periods and times the next '1'. If not comparable the check is rejected. This process is repeated up to the fifth transition as shown in Figure 3, each successive transition giving an improvement in the estimated value of a two-unit period. A single unit period is then derived and the two reference periods so produced used for assessing the durations of the plates and spaces of the subsequent data message. After each transition a comparison is made to determine the duration of the previous state as one unit or two and a further improvement in the estimated value of a single unit period is made, e.g. to cater for acceleration or braking of the train. The pattern is then apparent and the two-unit states can be split to give a series of single unit states exclusively. In Figure 3 the durations in units are:

1(1) 1(0) 1(1) 2(0) 2(1) 2(0) 1(1) 1(0) .....

On splitting, this becomes:

1 0 1 0 0 1 1 0 0 1 0 .....

On pairing according to the Manchester 2 code:

10 10 01 10 01 01

and hence a data message reading:

1 1 0 1 0 0

which is the digital address of a station or other location.

In order to make the transponder available for use by trains in both directions, on a single-line track for example, a sync pattern is provided at both ends of the message portion and a coded message portion incorporated which indicates to the driver (and to the central control) which way the train is going. The data message will of course be read in the wrong direction but this can be stored and read forward or backward according to the direction code.

The plates have been described as conductive plates which are suitable for detection by an inductive sensor, the plate providing in effect a short circuited secondary winding of a transformer the primary of which is energised in the proximity detector. The current drawn by the primary will increase in the presence of the plate and the current magnitude can be measured.

Alternatively, the plates may be essentially magnetic, thus increasing the inductance of a coil in the proximity detector and altering an oscillator frequency. The plates must of course be sufficiently remote from the magnetic/conductive rails. A central position between the rails is suitable both for this non-interference requirement and for single-line two-way running.

Again, the plates may form a common capacitor plate between two co-planar capacitor plates on the proximity detector thus again modulating the frequency of an oscillator.

In an alternative to the above serial arrangement of the signal code pattern, plates 29 may be arranged in parallel, i.e. across the track, as shown in Figure 4. In this case there is a respective proximity detector 25 for each plate position 27 and the bank of detectors reads the data message directly, without any 2-bit coding. Precautions have to be taken to ensure that for example, a

single detector triggered does not imply a data message. A parity or near parity code overcomes this difficulty. Alternatively, a combination serial/parallel arrangement may be employed in which the plates 29 are uniformly staggered along the travel direction to impose a time constraint on acceptable pulses.

In a further variation two serial rows of plates may be used, one providing a synchronisation pattern, say a regular series of plates equally spaced, while the other comprises the data message pattern of equal plates equally spaced but with certain ones (representing logical 0's) omitted.

Several advantages arise from the above described transponders:

(a) The transponder (which may be required in large quantities) consists only of common engineering materials, and it could therefore be made by relatively unskilled staff e.g. in a developing country.

(b) The transponder is capable (at zero or minimal additional cost) of conveying not only location information, but also direction of travel information to each passing train.

(c) The train may be economically fitted with more than one reader head (proximity detector) since they are simple and potentially inexpensive. The use of more than one head can help prevent loss of data in the event of the locomotive stopping with its reader head over the pattern.

(d) There is potential for measuring the speed of the train, by one of the following methods:

- From the bit rate calculated by the reader processor.
- By timing the train between two successive transponders.
- By timing between 2 heads on a locomotive passing over the same transponder.

Such methods of speed measurement operate independently of wheel slip/slide.

CLAIMS

1. A railway vehicle location system comprising a trackside transponder and a reader mounted on a railway vehicle, the transponder comprising a plurality of passive metal plates disposed adjacent the track in such relation to proximity detector means mounted on the vehicle that a signal pulse arises in the proximity detector means for the duration of proximity between the detector means and each metal plate as the vehicle passes the transponder, the plurality of plates thereby producing a signal code identifying to the vehicle the location of the transponder.

2. A system according to Claim 1, wherein said proximity detector means operates by magnetic induction.

3. A system according to Claim 1 or Claim 2, wherein said signal code is constituted by the length and relative position of said metal plates in a series.

4. A system according to Claim 1 or Claim 2, wherein said signal code comprises a series of code units, each code unit comprising a pair of opposite binary elements in an order determining the value of the code unit, one binary element being represented by a said metal plate and the other binary element being represented by the absence of metal plate in a predetermined position.

5. A system according to Claim 4, wherein said metal plates are disposed in the direction of travel and are of one or two units length interspersed with spaces of one or two units length, according to the value of successive code units, equal or different.

6. A system according to Claim 1 or Claim 2, wherein a signal code is constituted by the presence and absence of metal plates in a parallel array of similar metal plates relative to the direction of

vehicle travel, there being a respective proximity detector for each potential metal plate position.

7. A system according to Claim 6, wherein a signal code is constituted by the presence and absence of metal plates in a series/parallel array of similar metal plates, there being a respective proximity detector for each row of the array, the rows lying in the direction of vehicle travel.

8. A system according to Claim 5, wherein transitions between the presence and absence of said plates are detected and the signal code determined from the time between successive transitions.

9. A system according to Claim 5 or Claim 8, wherein the series of metal plates is preceded by a synchronisation pattern of metal plates indicating to the reader the timing of code units in the following series of metal plates.

10. A system according to Claim 9, wherein the series of metal plates is terminated by a said synchronisation pattern at both ends to accommodate vehicle travel in both directions.

11. A system according to Claim 10, wherein said series of metal plates includes a signal code indicative of the direction of travel.

12. A railway vehicle location system substantially as hereinbefore described with reference to the accompanying drawings.